FIXING DEVICE, IMAGE FORMING APPARATUS, METHOD

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to a fixing device, an image forming apparatus, and a fixing method.

DISCUSSION OF THE BACKGROUND

A background image forming apparatus (such as a copier, a facsimile, or a printer) fixes a toner image onto a recording medium with heat to make a copy of the image or to create a recorded medium. The toner image is fixed onto the recording medium by heating the toner image and the conveyed recording medium while the recording medium is being nipped, because the toner either melts or softens to allow the toner to permeate into the recording medium.

Japanese Published Unexamined Patent Application No. Hei 3-5779 shows an image forming apparatus including an upper pressing roller, an lower pressing roller, a main heater and a sub heater heating the upper pressing roller, a main power source supplying power to the main heater, and a rechargeable battery supplying power to the sub heater. This application further shows a charger configured to charge the rechargeable battery from the main power source, a switch to switch a electric double-layer capacitor so as to connect toor to disconnect from the heater, and a temperature sensor to sense the temperature of the upper pressing roller. This application furthermore shows a controller to control the switch switching the rechargeable battery to connect to or to disconnect from the sub heater based on comparing the sensed temperature by the temperature sensor to a threshold value of the temperature. In addition, Japanese Published Unexamined Patent Application No. Hei 2000-98799 and No. Hei 10-282821 show structures similar to those shown in JP 3-5779.

In these prior art references, the rechargeable battery can supply the power to the sub heater independent of the rating of the main power source. Thereby it is possible to rapidly heat the upper pressing roller independent of the rating of the main power source. However, these references are prone to rapid battery discharging and resultant multiple charging cycles which reduces the overall life of the battery.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a novel toner fixing device, image forming apparatus, and image forming method that result in increased lbattery life while providing tailored pre-heating functions.

It is another object of the present invention to provide a novel toner fixing device, image forming apparatus, and image forming method that optimizes power supplied from a battery to a heater in an image forming apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the present invention, and many of the attendant advantages thereof, will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

Fig. 1 is a schematic front view of an image forming apparatus according to the first through fourth embodiments of the present invention;

Fig. 2 is a schematic front view of a part of a fixing device in the first through fourth embodiments;

Fig. 3 is a control block diagram of the first through fourth embodiments;

Fig. 4A is a timing diagram for supplying power from a commercial power source to a heater in the first through fourth embodiments;

Fig. 4B is a timing diagram for supplying power from a battery unit to a heater in the first through fourth embodiments;

Fig. 5A is a timing diagram for supplying power from a commercial power source to the heater in the fifth embodiment of the present invention;

Fig. 5B is a timing diagram for supplying power from a battery unit to the heater in the fifth embodiment; and

Fig. 6 is a schematic front view of a part of a fixing device in the sixth embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, the description of the embodiments of the present invention will be made with reference to the above-listed drawings, wherein like reference numerals designate identical or corresponding parts through the several views. This application incorporates by reference priority document Japanese patent application JP2002-229260 filed on August 6,

2002.

Fig. 1 is a schematic front view showing an image forming apparatus according to the first through fourth embodiments of the present invention. The present invention is directed to other types of image forming apparatuses, as would be clearly understood by those of ordinary skill in the art. The image forming apparatus includes an image forming member 1 and an exposure unit 6. A charging member 2, a developing unit 3, a transfer member 4, and a cleaning member 5 are arranged around the image forming member 1. The charging member 2 and the developing unit 3 are arranged so that an irradiated light L from the exposure unit 6 passes between them so as to exposure the surface of image forming member 1.

According to this structure, the irradiated light L forms a static potential image on the surface of image forming member 1, after charging member 2 equally charges the surface of image forming member 1. Then developing member 3 makes the static potential image into a visible static image as a toner image. Further, cleaning member 5 removes the residual toner from image forming member 1 while in contact with image forming member 1, then a discharge member (not illustrated) initializes an electric potential on image forming member 1.

A sheet tray 7 with an intermediate plate 8 holding plural recording mediums is arranged at a lower part of the image forming apparatus. A feeding roller 9 and a separating member 10 are arranged about the sheet tray 7. The plural recording mediums are pressed up to feed roller 9 by a drive (not illustrated). Feed roller 9 feeds the upper recording medium on intermediate tray 8 while rotating and separating member 10 sequentially separates one recording medium from the stack of plural recording mediums.

A pair of resist rollers 11 is arranged above feeding roller 9. The pair of resist rollers 11 temporally stop and send the recording medium synchronous with the toner image forming operations performed by the image forming member 1. The sent recording medium is transferred from image forming member 1 by transfer member 4.

A fixing device 20 which fixes the toner image onto the recording medium by heat and pressure is located above the image forming member 1. A pair of ejecting rollers 16, which eject the recording medium, are located about the fixing device 20. A tray 17 is located at an upper part of the image forming apparatus 1. The tray 17 stacks the ejected recording medium, with the surface containing the toner image facing downward on the tray 17.

Fig. 2 is a schematic front view showing a part of the fixing device 20 of the first

through fourth embodiments. Fixing device 20 includes a fixing roller 21 as a fixing member, a pressing roller 22 as an opposite member formed opposite fixing roller 21, and a temperature sensor 24 configured to sense the surface temperature of fixing roller 21. Temperature sensor 24 may sense the surface temperature of pressing roller 22. Fixing roller 21 includes two heaters 23a, 23b configured to heat fixing roller 21. Pressing roller 22 includes an elastic layer such as silicone rubber and presses fixing roller 21 by a pressing source (not illustrated). Fixing roller 21 and pressing roller 4 form a nip between them, and toner image TG is fixed onto the recording medium P while passing through the nip.

Fig. 3 is a control block view of the first through fourth embodiments. The image forming apparatus includes a controller 40, a driver 41, an input circuit 42, and a commercial power source 43 as a main power source supplying power to heater 23a through driver 41. Input circuit 42 inputs a signal from temperature sensor 24 and outputs a signal according to the signal input from the temperature sensor 24. Commercial power source 43 supplies power to a battery unit 45 through a charger 44 and a switch 46 with a port S1 and a port S2. Charger 44 converts AC power supplied from commercial power source 43 to DC power, then charges battery unit 45 with the converted DC power. Battery unit 45 supplies power to heater 23b. Switch 46 connects battery unit 45 to charger 44, and disconnects battery unit 45 from heater 23b when switching to port S1. Switch 46 connects battery unit 45 to heater 23b and disconnects battery unit 45 from charger 44 when switching to port S2. Switch 46 may include another port disconnecting battery unit 45 from both charger 44 and heater 23b.

Controller 40 controls driver 41 to be in an OFF state so as not to supply power to the heater 23a during a standby time. Controller 40 controls the on-off operations of driver 41 based on comparing the temperature sensed by temperature sensor 24 to a threshold value of temperature during a ramp-up period, and while plural recording medium continuously pass through the nip. The threshold value of the temperature is determined based on the necessary temperature to fix the toner image onto the recording medium. In particular, controller 40 controls driver 41 to an ON state so as to supply power to heater 23a when the temperature is less than the threshold value, and controls driver 41 to an OFF state so as not to supply power to heater 23a when the temperature is greater than the threshold value.

Further controller 40 controls switch 46 to switch to port S1 or port S2 based on comparing the temperature sensed by the temperature sensor 24 to the threshold value of the temperature while plural recording medium continuously pass the nip. In particular, controller 40 controls battery unit 45 to connect heater 23b when the temperature is less than the threshold value, and controls battery unit 45 to disconnect heater 23b when the

temperature is greater than the threshold value. Therefore the surface temperature of fixing roller 21 is almost kept the threshold value of the temperature while plural recording medium continuously passing the nip. During the standby time and ramp-up period, controller 40 controls switch 46 to switch to port S1 independently of the surface temperature of fixing roller 21.

Further in this embodiment, battery unit 45 includes an electric double-layer capacitor. The electric double-layer capacitor can supply higher-density power of at least three times than a lead acid battery and a nickel cadmium battery; thereby it can supply large power in a short time. Therefore the temperature of heater 23b can rise rapidly.

Advantageously, the electric double-layer capacitor charges and discharges by physical absorption of ions, not by chemical reaction. Thus, the capacitor's lifetime is less vulnerable to a reduction in life span resulting from repeated charging and discharging than would be a normal chemical reaction battery. Thus, the lifetime of battery unit 45 that is configured to be switched based on comparing the temperature sensed by the temperature sensor 24 to a temperature threshold value is longer when the battery unit 45 is equipped with an electric double-layer capacitor than a conventional battery unit that is equipped with a conventional battery.

Further charger 44 and battery unit 45 are preferably not mounted on fixing device 20. Thereby charger 44 and battery unit 45 can be detachable from the image forming apparatus independently from fixing device 20. Therefore, it is not necessary to detach the electric double-layer capacitor with the long lifetime from the image forming apparatus when the fixing device 20 is detached from the image forming apparatus for maintenance or other purposes.

Fig. 4A is a timing diagram view showing supplied power from the commercial power source 43 to the heater 23a. Fig. 4B is a timing diagram view showing supplied power from the battery unit 45 to the heater 23b.

During a standby time, controller 40 controls driver 41 such that commercial power source 43 does not supply power to heater 23a. Controller 40 also controls switch 46 such that charger 44 charges battery unit 45 until the voltage of battery unit 45 reaches a predetermined voltage.

During the ramp-up period, controller 40 controls driver 41 such that commercial power source 43 supplies power to heater 23a. Controller 40 also controls switch 46 such that battery unit 45 disconnects heater 23b.

While plural recording medium continuously pass through the nip, controller 40

controls driver 41 such that commercial power source 43 supplies power to heater 23a. Controller 40 also outputs a starting signal to switch 46 when the temperature sensed by temperature sensor 24 is less than a threshold value of the recording medium temperature. Switch 46 connects battery unit 45 to heater 23b based on the starting signal, then battery unit 45 starts supplying power to heater 23b. Controller 40 outputs a finishing signal to switch 46 when the temperature sensed by temperature sensor 24 is greater than a threshold value. Switch 46 disconnects battery unit 45 from heater 23b based on a finishing signal, then battery unit 45 finishes supplying power to heater 23b.

In the Fig. 4A, 4B, the starting signal and the finishing signal are each output once while plural recording medium continuously pass through the nip. The starting signal and the finishing signal each can be repeatedly output more than once when the number of the recording medium is large. However, as explained previously, although battery unit 45 is repeatedly switched to discharge or charge, the lifetime of battery unit 45 is longer than conventional battery units because battery unit 45 includes the electric double-layer capacitor.

In a second embodiment of the present invention, controller 40 outputs the starting signal after the temperature sensed by temperature sensor 24 continuously decreases during a predetermined period, and before the sensed temperature continuously falls below a temperature necessary to fix the toner image onto the recording medium, said drop in temperature caused in part by heat being absorbed from the fixing member by the passing recording medium. Switch 46 connects battery unit 45 to heater 23b based on the starting signal, then battery unit 45 starts supplying power to heater 23b. Meanwhile controller 40 outputs the finishing signal when the temperature sensed by temperature sensor 24 is greater than a temperature threshold value. Switch 46 disconnects battery unit 45 from heater 23b based on the finishing signal, then battery unit 45 finishes supplying power to heater 23b.

Thereby controller 40 is prevented from unnecessarily outputting the starting signal multiple times that might be caused by transitional changes in temperature on the fixing roller 21. Therefore the lifetime of battery unit 45 is longer than conventional battery units because battery unit 45 is prevented from being repeatedly switched to discharge or not. Thereby in this second embodiment, battery unit 45 may not necessarily include the electric double-layer capacitor.

In addition, the toner image is more reliably fixed onto the recording medium, because heater 23b can heat fixing roller 21 before the temperature on fixing roller 21 falls below the necessary temperature to fix the toner image onto the recording medium, said drop in temperature caused in part by heat being absorbed from the fixing member by the passing

recording medium.

In the third embodiment of the invention, controller 40 outputs a starting signal when a decreasing rate of the temperature sensed by temperature sensor 24 is over a predetermined decreasing rate of the temperature, and before the sensed temperature continuously falls below the necessary temperature to fix the toner image onto the recording medium. Switch 46 connects battery unit 45 to connect heater 23b based on the starting signal, then battery unit 45 starts supplying power to heater 23b. Meanwhile controller 40 outputs the finishing signal when the temperature sensed by temperature sensor 24 is greater than a threshold value of the temperature. Switch 46 switches battery unit 45 to disconnect from heater 23b based on the finishing signal, then battery unit 45 finishes supplying power to heater 23b.

Thereby controller 40 is prevented from outputting the starting signal many times that might be caused by the transitional changes in the temperature on fixing roller 21. Therefore the lifetime of battery unit 45 is longer than conventional battery units because battery unit 45 is prevented from being repeatedly switched to discharge or not. Thereby in this modification, battery unit 45 may not necessarily include the electric double-layer capacitor.

In addition in this modification, the toner image is more reliably fixed onto the recording medium, because heater 23b can heat fixing roller 21 before the temperature on fixing roller 21 falls below the necessary temperature to fix the toner image onto the recording medium, said drop in temperature caused in part by heat being absorbed from the fixing member by the passing recording medium.

In the fourth embodiment, controller 40 calculates a heat load based on the number or a kind of the recording medium. Then controller 40 outputs the starting signal when the calculated heat load is greater than the predetermined heat load, and before the sensed temperature continuously falls below the necessary temperature to fix the toner image onto the recording medium. Switch 46 connects battery unit 45 to connect heater 23b based on the starting signal, then battery unit 45 starts charging to heater 23b. Meanwhile controller 40 outputs a finishing signal when the temperature sensed by temperature sensor 24 is greater than a threshold value of the temperature. Switch 46 switches battery unit 45 to connect to heater 23b based on the finishing signal, then battery unit 45 finishes supplying power to heater 23b.

Thereby controller 40 is prevented from outputting the starting signal many times that might be caused by transitional changes in the temperature on fixing roller 21. Therefore the lifetime of battery unit 45 is longer than conventional battery units because battery unit 45

is prevented from being repeatedly switched to discharge or charge. Thereby in the fourth embodiment, battery unit 45 may not necessarily include the electric double-layer capacitor.

In addition, in the fourth embodiment the toner image is more reliably fixed onto the recording medium because heater 23b can heat fixing roller 21 before the temperature on fixing roller 21 falls below the temperature necessary to fix the toner image onto the recording medium, said drop in temperature caused in part by heat being absorbed from the fixing member by the passing recording medium.

Further, controller 40 preferably holds data showing the relation between the heat load and the number and/or type of the recording medium. Controller 40 thereby calculates the heat load and further rewrites the data based on the sensed temperature. Thus, heater 23b can be controlled to heat fixing roller 21 at the appropriate timing.

Fig. 5A is a timing diagram view showing supplied power from commercial power source 43 to heater 23a in a fifth embodiment of the present invention. Fig. 5B is a timing diagram view showing supplied power from battery unit 45 to heater 23b in the fifth embodiment.

In the fifth embodiment, battery unit 45 can supply power in two modes of operations: limited and non-limited power.

In the limited power mode of operation, controller 40 outputs a starting signal during a ramp-up period. Switch 46 connects battery unit 45 to heater 23b based on the starting signal, then battery unit 45 starts supplying limited power to heater 23b. Meanwhile controller 40 outputs a finishing signal after a predetermined period after outputting the starting signal. Switch 46 disconnects battery unit 45 to heater 23b based on the finishing signal, then battery unit 45 finishes supplying the limited power to heater 23b.

During non-limited operations, plural recording medium are continuously passing through the nip. Controller 40 outputs the starting signal and the finishing signal to switch 46 according to each condition mentioned above. Switch 46 connects battery unit 45 to heater 23b based on the starting signal, then battery unit 45 starts supplying the non-limited power to heater 23b. Switch 46 disconnects battery unit 45 from heater 23b based on the finishing signal, then battery unit 45 finishes supplying the non-limited power to heater 23b.

Thereby it is possible to raise the temperature on fixing roller 21 rapidly during the limited operations, while conserving battery power to later supply to power to heater 23b while plural recording medium are continuously passing through the nip. In this embodiment, battery unit 45 may not necessarily include the electric double-layer capacitor.

Fig. 6 is a schematic front view showing the substantial part of a fixing device 20B in

a sixth embodiment of the present invention. Fixing device 20B includes a fixing belt 25 as a fixing member, a fixing roller 21 heating fixing belt 25, a supporting member 26 supporting fixing belt 25 and fixing roller 21. Fixing device 20B further includes pressing roller 22 opposite supporting roller 26 and fixing belt 25. Temperature sensor 24 is configured to sense the surface temperature of fixing belt 25. Fixing roller 21 includes two heaters 23a, 23b configured to heat fixing roller 21. Pressing roller 22 includes an elastic layer such as silicone rubber and nips to press fixing belt 25 together with supporting roller 26 by a pressing source (not illustrated). Fixing belt 25 and pressing roller 4 form the nip between them so that the toner image TG is fixed onto the recording medium P when passing through the nip.